
कॉपर के निर्धारण के तरीके

(पहला पुनरीक्षण)

Methods of Determination of Copper

(First Revision)

ICS 71.060

© BIS 2023



भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002

www.bis.gov.in www.standardsbis.in

January 2023

Price Group 5

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Inorganic Chemicals Sectional Committee had been approved by the Chemical Division Council.

Copper in micro and macro quantities is required to be determined in various products. Numerous methods are available for its determination in all ranges but a few have been found to be more convenient and suitable and these are now used in preference to others. For example, electrodeposition on a platinum gauze cathode is an excellent method but is time consuming. This is used for determining copper in macro quantities where large batch of samples can be simultaneously electrolyzed in a battery of electrolytic cells. It is also used where the volumetric iodide method cannot be employed due to any reason. The volumetric iodide method is a very rapid and convenient method for determining macro quantities of copper. For micro-analysis of copper, several organic reagents are used but more common reagent is the diethyldithiocarbamate, Biquinoline [2,2-biquinolyl or 2-(2-quinolyl)-quinoline] is also considered to be most suitable but its use is under investigation with the Committee.

This standard was originally published in 1974. This standard is revised to update the reference clause and incorporate the instrumental test methods for the determination of copper. The editorial corrections have also been made, wherever required.

This standard is intended to achieve uniformity of the method for the determination of copper prescribed in various Indian Standards.

The composition of the committee responsible for formulation of this standard is listed in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

METHODS OF DETERMINATION OF COPPER

(*First Revision*)

1 SCOPE

This standard prescribes various test methods for the determination of copper in micro and macro quantities. Depending upon the sample in which copper is to be determined, any suitable test method as given in this Standard may be used.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute the provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

<i>IS No.</i>	<i>Title</i>
IS 264 : 2005	Nitric acid – Specification (<i>third revision</i>)
IS 266 : 1993	Sulphuric acid – Specification (<i>third revision</i>)
IS 1070 : 1992	Reagent grade water – Specification (<i>third revision</i>)
IS 2263 : 1979	Methods of preparation of indicator solutions (<i>first revision</i>)
IS 2316 : 1990	Methods of preparation of standard solutions for colorimetric and volumetric analysis (<i>second revision</i>)
IS 3025 (Part 2) : 2019/ISO 11885 : 2007	Methods of sampling and test (physical and chemical) for water and wastewater: Part 2 Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP- OES) (<i>first revision</i>)
IS 3025 (Part 42) : 1992	Methods of sampling and test (physical and chemical) for water and wastewater: Part 42 Copper (<i>first revision</i>)

*IS No.**Title*

IS 3025 (Part 65) : 2014/ISO 17294-2 : 2003 : Methods of sampling and test (physical and chemical) for water and wastewater: Part 65 Application of inductively coupled plasma mass spectrometry (icp-ms) — Determination of 62 elements

IS 4161 : 1967 Specification for nessler cylinders

3 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS1070) or demineralized water (demineralized through ion-exchange resin) shall be used in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities that affect the results of the analysis.

4 PREPARATION OF SOLUTION

Before carrying out the analytical procedures, the copper in test samples has to be brought into solution. In most cases, attack by nitric acid is enough; occasionally sulphuric acid, fuming, has to follow this attack. In case of organic matter and biological samples attack by sulphuric acid and an oxidizing agent (usually hydrogen peroxide) is required but direct ashing by ignition can also be done. Highly siliceous samples may be opened up with hydrofluoric acid and sulphuric acid treatment or by fusion with pyrosulphate. In all cases, the whole of the copper comes into the acidic solution and insoluble residue, if any, can be filtered out. There is no volatile loss of copper in ashing, fusion or during fuming of sulphuric acid. The ashing is done at a temperature not exceeding 600 °C.

5 ELECTROLYTIC DETERMINATION OF COPPER**5.1 Outline of the Method**

Electrolysis is carried out in a weak acidic solution and copper deposited on a platinum gauze electrode is weighed.

5.2 Apparatus

5.2.1 Electrolytic Apparatus

A suitable apparatus for electrolysis with or without agitation of the electrolyte.

5.2.2 Electrodes

Platinum gauze electrode having a surface area of about 1 cm².

5.3 Reagents

5.3.1 Solvent-Acid Mixture

Add 200 ml of concentrated sulphuric acid (*see* IS 266) to 500 ml of water, then add 200 ml of concentrated nitric acid (*see* IS 264).

5.3.2 Dilute Nitric Acid — 1:1 by Volume

5.4 Procedure

5.4.1 Weigh accurately the material containing between 0.1 to 0.3 g of copper and transfer to a beaker provided with a watch glass. Dissolve the material in the solvent-acid mixture. Generally 20 ml of the mixture is required per gram of the sample. Add further 10 ml of the mixture. When the dissolution is complete, boil vigorously by adding a pinch of urea or sulphamic acid to drive off the nitrous fumes and cool. Wash the watch glass and sides of the beaker carefully. Dilute the contents to about 200 ml with water.

5.4.2 Clean the electrodes by immersing in dilute nitric acid, followed by washings with water, immersing in absolute alcohol and finally drying at 105 °C for about 10 min. Weigh the cathode accurately and fit the electrodes in the electrolysis apparatus so that they are as near to the bottom of the beaker as possible. Cover the beaker with a pair of split watch glass and electrolyze for 18 h at 1.0 ampere with a static electrolyte or for 2 h to 3 h at 4 amperes with the agitation of the solution. At the end of this period wash the cover glass and sides of the beaker and continue the electrolysis for another 30 min. This will increase the volume of the solution, thus immersing a little more portion of the cathode surface, and if no more copper is deposited on this freshly immersed surface, remove the cover glass and lower the beaker with the current still switched on, simultaneously washing the electrodes with a jet of water from a wash bottle. Switch off the current and remove the cathode, immerse it in absolute alcohol and dry at 105 °C for 10 min. Weigh the cathode and calculate the increase in mass due to metallic copper.

5.5 Calculation

Copper (as Cu), percent by mass

$$= \frac{M_2 - M_1}{M} \times 100$$

where

M_2 = mass in g of the cathode after electro deposition,

M_1 = mass in g of the cathode before electro-deposition, and

M = mass in g of the material taken for the test.

NOTES

- 1 All the copper should be removed from the solution but, as an additional safeguard, examine the electrolyte as follows:

Add 20 ml of citric acid solution (30 percent, *m/v*) followed by ammonium hydroxide (18 N) until the solution is distinctly alkaline, then add 10 ml in excess, followed by 10 ml of sodium diethyldithiocarbamate (0.1 percent, *m/v*). If a brown colour is produced, extract with carbon tetrachloride, determine the copper approximately by calorimetric method by visual comparison (*see* 6) and add it to the above results.

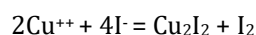
- 2 Any insoluble residue, after the initial acid treatment, should be filtered, ignited, fused with potassium pyrosulphate, the melt dissolved in water and added to the electrolyte before electrolysis. If lead is known to be present, it may be precipitated as sulphate in the solution of the sample, filtered, washed well with sulphuric acid (2 percent) and rejected.

6 VOLUMETRIC IODIDE METHOD

6.1 Outline of the Method

This is a rapid method with high degree of accuracy but it is subject to interference by many other elements. Most of these interferences lead to very slight error only if proper pH is maintained at the time of titration.

Cupric ions react with iodide ions in which cuprous iodide and equivalent amount of iodine are formed as per the reaction



The liberated iodine is determined by titration against the standard thiosulphate solution. The reaction and the titration are best carried out at a pH of 3.5 to 4.0. At pH widely different from this, the results obtained are not accurate.

6.2 Reagents

6.2.1 Ammonium Hydroxide Solution — 18 N

6.2.2 Ammonium Bifluoride Solution — nearly saturated. Keep in polyethylene containers.

6.2.3 Potassium Iodide Solution — fifty percent (*m/v*), freshly prepared solution.

6.2.4 Standard Sodium Thiosulphate Solution — 0.1 N

(*see* 55 of IS 2316)

6.2.5 Starch Solution

Fresh, 0.5 percent (m/v) (see IS 2263)

6.2.6 Copper Metal — Electrolytically Pure**6.2.7 Urea — Solid****6.2.8 Potassium Thiocyanate — Solid****6.3 Procedure**

Make the solution of the material in nitric acid. If the material is insoluble in nitric acid, sulphuric acid may be also added. But, if hydrochloric acid is used, this reagent should be removed by evaporation with sulphuric acid before neutralization. Transfer a known aliquot of solution containing up to 0.3 g of copper in a 250 ml stoppered conical flask. Remove the stopper, evaporate the solution to about 2 ml or 3 ml carefully, taking care that no part of the solution is evaporated to dryness. Dilute to about 50 ml. Add 1 g of urea and boil for about a min with stopper on. Cool, add ammonium hydroxide drop by drop with swirling, until a permanent precipitate is formed and a faint smell of ammonia is noticed in the solution after keeping it for a min or two. (This precipitate is usually, though not always, brown due to ferric hydrated oxide; but the supernatant liquid is always, more or less, bluish or blue). Avoid adding too much excess of ammonia. Add ammonium bifluoride solution drop by drop with thorough mixing until the brown precipitate redissolves and any yellow of red tinge in the solution disappears. Add 1 ml more.

Add about 4 ml to 6 ml of potassium iodide solution and mix with stopper on. Keep for 2-3 min (preferably in dark). Titrate the liberated iodine with standard thiosulphate solution until the iodine colour lightens, then add about 5 ml of starch solution and 2 g - 3 g of potassium thiocyanate and continue the titration until the starch colour is discharged. Add about 2 ml of potassium iodide solution more and mix. If the starch colour reappears, continue the titration as above. Repeat until on addition of more potassium iodide; starch colour does not reappear.

NOTES

1 Starch solution contains two kinds of starch, one of which is present in major proportion and gives blue colour with iodine. The other type is present in minor proportion only and gives a red colour with iodine. The red colour is more stable than blue. On titration, the original colour, which is almost blue, gradually changes to violet and then to red as the less stable blue starch colour is progressively discharged by thiosulphate. At the end point, it is the red starch colour which disappears.

2 The addition of solid urea and boiling for a min and cooling can be omitted if the sample solution is known to be free from nitric acid.

6.4 Calculation

Copper (as Cu), percent by mass

$$= \frac{6.354}{M} \times VN$$

where

V = volume in ml of standard sodium thiosulphate solution used in titration,

N = normality of standard sodium thiosulphate solution, and

M = mass in g of the material taken for the test.

7 PHOTOMETRIC (COLORIMETRIC) METHOD**7.1 Outline of the Method**

Sodium diethyldithiocarbamate by reaction in acid, neutral or alkaline solution, gives the copper salt by diethyldithiocarbamic acid which has a golden yellow colour. The complex is extracted with carbon tetrachloride and photometrically determined. By this treatment all interfering elements except bismuth are eliminated.

7.2 Apparatus

Photometer — Any suitable photoelectric colorimeter.

7.3 Reagents

7.3.1 Ammonium Citrate Solution — 40 Percent (m/v).

7.3.2 Sodium Diethyldithiocarbamate Solution — 0.1 percent (m/v).

7.3.3 Standard Copper Solution

Clean the surface of a copper wire with sand paper. Dissolve 1 000 g of pure copper in dilute nitric acid. Heat the solution nearly to dryness to drive off the acid. Add about 10 ml of water and heat again nearly to dryness. Take up the residue in water, add 25 ml of 1 N sulphuric acid and dilute to 1 000 ml. One millilitre of this solution contains 0.1 mg of copper (as Cu). Alternatively, dissolve 3.928 g of cupric sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in sufficient water containing 1 or 2 ml of concentrated sulphuric acid and dilute to 1 000 ml. One millilitre of the solution contains 1.0 mg of copper (as Cu).

7.3.4 Ammonium Hydroxide — 18 N

7.3.5 Carbon Tetrachloride

7.4 Procedure

Prepare the solution of the sample as prescribed in the relevant material specification. Transfer an aliquot containing not more than 0.05 mg of copper

to a 100 ml separating funnel. Add 2 ml of ammonium citrate solution and adjust the pH to 8.5 with ammonium hydroxide. The presence of ammonium ions helps to deionize iron, if present, and to prevent rapid fading of developed colour.

Add 10 ml of sodium diethyldithiocarbamate solution and develop the colour. Extract the coloured complex with 5 ml to 10 ml of carbon tetrachloride. Separate the carbon tetrachloride layer from aqueous layer and centrifuge for 5 min to separate the water droplets. Transfer the carbon tetrachloride solution to a photometric cell and measure its absorbance at the wavelength of maximum absorption, 440 nm relative to the reagent blank. Calculate the corrected absorbance by subtracting the reading obtained for the solution containing no copper.

Transfer to a series of 100 ml separating funnels aliquots of standard copper solution corresponding to 0 g, 5 g, 10 g, 15 g, 20 g, 25 g of copper and proceed exactly as prescribed in 7.4.1. Plot a graph of corrected absorbance of solutions against their copper contents.

NOTE — If bismuth is suspected, it has to be separated or otherwise accounted for.

7.5 Calculation

Calculate the corrected absorbance by subtracting the value obtained for the blank from that obtained for the test solution and read from the calibration curve the corresponding mass of copper.

Copper (as Cu), percent by mass

$$= \frac{M_1}{M_2} \times 100M$$

where

M_1 = mass in g of copper as determined in the given aliquot of the test solution, and

M_2 = mass in g of the material present in the aliquot of the test solution.

8 BIQUINOLINE METHOD

8.1 Outline of the Method

Copper reduced to cuprous state by hydroxylamine hydrochloride, reacts with 2, 2-biquinoline solution in normal or isoamyl alcohol, to give a pinkish-violet colour in the organic liquid layer. This colour is stable and may be measured visually or spectrophotometrically over a wide range and is proportional to the amount of copper present. Best working pH range is between 5 to 6. Quantitative results can, however, be obtained if the copper content is limited to 50 µg. No other metal interferes.

NOTE — This method is suitable for materials of low copper content and will need some modification depending on nature of material. Copper in iron ore, steel or special alloy steel cannot be determined unless iron is reduced with

excess of sulphurous acid. Hydroxylamine hydrochloride will be inadequate for the purpose. Organic matter, if present should be burnt.

8.2 Apparatus

8.2.1 *Nessler Cylinders* — see IS 4161.

8.2.2 *Spectrophotometer* — Visible range 400 to 800 nm.

8.3 Reagents

8.3.1 Buffer Solution

Dissolve 400 g of sodium acetate trihydrate, 20 g of hydroxylamine hydrochloride and 100 g of sodium tartrate in one litre of water. The pH of the buffer should be adjusted between 6 to 7. The buffer should be cleaned by shaking with 10 ml of biquinoline solution in a separating funnel of one litre capacity. If the organic liquid becomes pinkish violet it should be removed and the process repeated till the organic liquid layer becomes perfectly colourless.

8.3.2 Biquinoline Solution

Dissolve 0.2 g of 2, 2'-biquinoline reagent in 800 ml to 900 ml of isoamyl alcohol by warming. Cool and make up to 1 litre with the same alcohol. Normal amyl alcohol can also be used in place of isoamyl alcohol.

NOTE — No special storage precautions are necessary for the above reagents but it may be useful to keep them away from strong sunlight. The buffer may be kept in a refrigerator and biquinoline solution in amber coloured tightly stoppered bottle.

8.3.3 Standard Copper Solution

8.3.3.1 100 micrograms per ml

Dissolve 0.200 g of copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in 0.1 N hydrochloric acid and dilute to 500 ml with the acid.

8.3.3.2 10 microgram per ml

Transfer 10 ml of standard solution (a) to a 100 ml volumetric flask and dilute to 100 ml with 0.1 N hydrochloric acid.

8.4 Procedure

8.4.1 Visual

Transfer to a number of Nessler cylinders aliquots of standard copper solution (see 8.3.3.2) corresponding to 0.0 µg, 0.2 µg, 0.5 µg, 1.0 µg, 2.0 µg, 3.0 µg, 4.0 µg and 5 µg of copper. Add 10 ml of buffer solution and mix well. Then add 2 ml of biquinoline solution, tightly stopper and shake vigorously for 2 min, allow the layers to separate. For semiquantitative analysis the colour obtained in the organic liquid layer, in case of test sample similarly treated, is visually compared against similar colour in case of standards and the value of the standard in

which it most nearly matches, is taken to be the value for the test sample.

The test sample will pass the limit test if the colour in the organic liquid layer, in case of test sample, is equal to or less than that in cast of standard solution,

8.4.2 Spectrophotometrically

Three extractions of copper solution with 10 ml biquinoline solution are required for complete extraction of copper. Biquinoline solution is added as 5 ml, 2.5 ml and 2.5 ml increments and shaking each time for 2 min.

8.4.2.1 Decompose sample in a suitable manner and dissolve in dilute hydrochloric acid. Transfer aliquot of solution containing not more than 50 µg of copper to a separating funnel of 50 ml capacity. Add 10 ml of buffer solution. Check pH at about 6 (use narrow range pH paper or pH meter). Volume of solution should be between 15 ml to 20 ml. Shake with 0.5 ml of biquinoline solution for 2 min.

8.4.2.2 Allow the phases to separate and run the lower layer into another separating funnel, and extract with 2.5 ml of biquinoline solution. Take the lower layer into another separating funnel and again extract with 2.5 ml biquinoline solution. Combine the extracts, mix well, filter dry into 1 cm cell and measure absorbance at 545 nm against reagent blank with spectrophotometer. Take 0.0 ml, 1.0 ml, 2.0 ml, 3.0 ml, 4.0 ml and 5 ml solution (*see 8.3.3.2*) in 50 ml separating funnel. Add 10 ml buffer solution and proceed as above and draw calibration curve for the range 0 µg to 50 µg copper. Find out the copper content corresponding to the absorbance of the test

solution.

NOTE — The copper complex formed with 2,2'-biquinoline is not a strong complex. Ions that form strong complexes with copper, such as ammonium prevent the reaction of copper with 2,2'-biquinoline and therefore should not be present during the test. Inorganic material is present and organic compounds are extracted by isoamyl alcohol, their yellow colour will mask the colour of the copper biquinoline complex. If samples of high organic matter are ignited at 450 °C, interference from organic compounds can be prevented.

9 DETERMINATION OF COPPER USING INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROMETRY (ICP-OES) METHOD

Copper can be determined using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method as prescribed in IS 3025 (Part 2).

10 DETERMINATION OF COPPER USING ATOMIC ABSORPTION METHOD (AAS) METHOD

Copper can be determined using Atomic Absorption Method (AAS) method as prescribed in IS 3025 (Part 42).

11 DETERMINATION OF COPPER USING INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS)

Copper can also be determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) method as prescribed in IS 3025 (Part 65).

ANNEX A
(Foreword)

COMMITTEE COMPOSITION

Inorganic Chemicals Sectional Committee, CHD 01

<i>Organization</i>	<i>Representative(s)</i>
Central Salt and Marine Chemicals Research Institute, Bhavnagar	DR KANNAN SRINIVASAN (<i>Chairperson</i>)
Alkali Mfrs Association of India, Delhi	SHRI K. SRINIVASAN SHRI H. S. DAS (<i>Alternate</i>)
Bhabha Atomic Research Centre, Mumbai	DR A. V. R. REDDY DR S. N. ACHARY (<i>Alternate</i>)
Central Drugs Standard Control Organization	DR RAMAN MOHAN SINGH
Consumer Voice, Delhi	SHRI M. A. U. KHAN SHRI K. C. CHAUDHARY (<i>Alternate</i>)
DGQA, New Delhi	DR GURBACHAN SINGH SHRI B. S. TOMAR (<i>Alternate</i>)
Hindalco, Mumbai	SHRI NAGESWAR KAPURI SHRI AJITH RAMACHANDRA (<i>Alternate</i>)
Geological Survey of India, Kolkata	SHRI P. V. V. R. SARMA
Global Adsorbents Pvt Ltd, Kolkata	SHRI SANJAY DHANUKA
Grasim Industries Ltd, Nagda	SHRI ALOK SINGH SHRI PANKAJ GUPTA (<i>Alternate</i>)
Gujarat Alkalies and Chemicals Ltd, Vadodara	SHRI V. K. MAHIDA SHRI SHAILESH PATEL (<i>Alternate</i>)
Hindustan Lever Ltd, Mumbai	MS VRINDA RAJWADE SHRI SOJAN VARGHESE (<i>Alternate</i>)
Indian Chemical Council (ICC)	DR U. SHETKAR DR RAKESH KUMAR (<i>Alternate</i>)
Indian Institute of Chemical Technology, Hyderabad	DR PRAVEEN R. LIKHAR DR RAJENDER REDDY (<i>Alternate</i>)
Industrial Carbon Pvt Ltd, Ankleshwar	SHRI SATYAN ROHIT KUMAR
Ministry of Chemicals & Fertilizers	DR ROHIT MISRA DR O. P. SHARMA (<i>Alternate</i>)
Ministry of Defence (DGQA), Kanpur	SHRI R. N. APARAJIT
National Chemical Laboratory, Pune	DR DARBHA SRINIVAS DR PARESH DHEPE (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
National Metallurgical Laboratory, Jamshedpur	DR TRILOCHAN MISHRA SHRI DEVBRATA MISHRA (<i>Alternate</i>)
National Mineral Development Corporation Ltd, Hyderabad	SHRI RAJAN KUMAR DR PRASHANT SHARMA (<i>Alternate</i>)
National Peroxide Ltd	DR JOY ANTHONY
National Physical Laboratory, New Delhi	DR NAHAR SINGH DR S. P. SINGH (<i>Alternate</i>)
National Test House (NR)	MS RICHA KUNDRA
Office of the Development Commissioner (MSME), New Delhi	DR KARTHIKEYAN MS ANNA BACKIAM (<i>Alternate</i>)
Shriram Institute for Industrial Research, Delhi	DR (MS) LAXMIRAWAT SHRI B. GOVINDAN (<i>Alternate</i>)
Tamil Nadu Petroproducts Limited, Chennai	SHRI RAVI MUTHUKRISHNAN
Tata Chemicals Ltd, Gujarat	SHRI NAJMUL HASAN KHAN
The Dharamsi Morarji Chemicals Co Ltd	SHRI MANDAR GAIKWAD
Vaibhav Analytical Services, Ahmedabad	SHRI GAURANG OZA
In Personal Capacity (514, Veer apt Sector 13, Rohini, Delhi 110085)	SHRI D. K. JAIN
BIS Directorate General	SHRI A. K. LAL, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (CHEMICAL DEPARTMENT) [REPRESENTING DIRECTOR GENERAL (<i>Ex-officio</i>)]

Member Secretary
SHRI SAGAR SINGH
SCIENTIST 'C'/DEPUTY DIRECTOR
(CHEMICAL DEPARTMENT), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 2016* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Head (Publication & Sales), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website- www.bis.gov.in or www.standardsbis.

This Indian Standard has been developed from Doc No.:CHD 01(18255).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402

Website: www.bis.gov.in

Regional Offices:

	Telephones
Central : 601/A, Konnectus Tower -1, 6 th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	{ 2323 7617
Eastern : 8 th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	{ 2367 0012 2320 9474
Northern : Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	{ 265 9930
Southern : C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	{ 2254 1442 2254 1216
Western : Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093	{ 2821 8093

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. CHANDIGARH. CHENNAI. COIMBATORE. DEHRADUN. DELHI. FARIDABAD. GHAZIABAD. GUWAHATI. HIMACHAL PRADESH. HUBLI. HYDERABAD. JAIPUR. JAMMU & KASHMIR. JAMSHEDPUR. KOCHI. KOLKATA. LUCKNOW. MADURAI. MUMBAI. NAGPUR. NOIDA. PANIPAT. PATNA. PUNE. RAIPUR. RAJKOT. SURAT. VISAKHAPATNAM.